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(54) Abstract Title

I.c. engine exhaust pressure regulating valve

(57) An exhaust pressure regulating valve is described for an internal combustion engine, comprising an exhaust duct 10 defining a through passage for the exhaust gases and a closure flap 30 for obstructing the through passage. The closure flap 30 is freely suspended to pivot under its own weight from a fulcrum lying above its centre of gravity and is deflected by the mass flow of exhaust gases along the through passage to create a regulated exhaust back pressure. The closure flap 30 and its pivot are entirely contained within the exhaust duct 10. In a modification (fig.3), the flap (30') has two spaced apertures (36') which engage two bent prongs projecting from the mounting plate 22. The flap 30 may be locked in the open position, as shown in fig.2 by a rod 40 guided within a sheath 42 (eg a Bowden cable) and actuated by a signal from the engine management system.

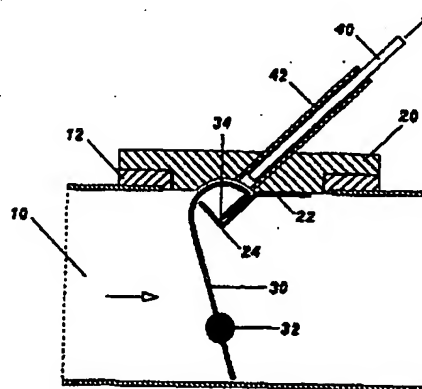


Fig. 1

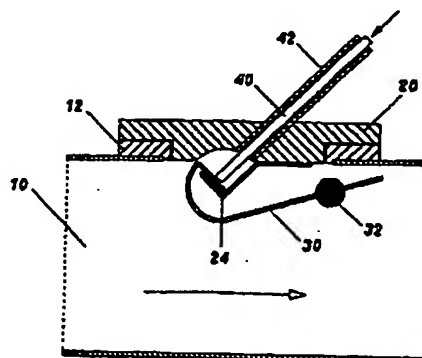


Fig. 2

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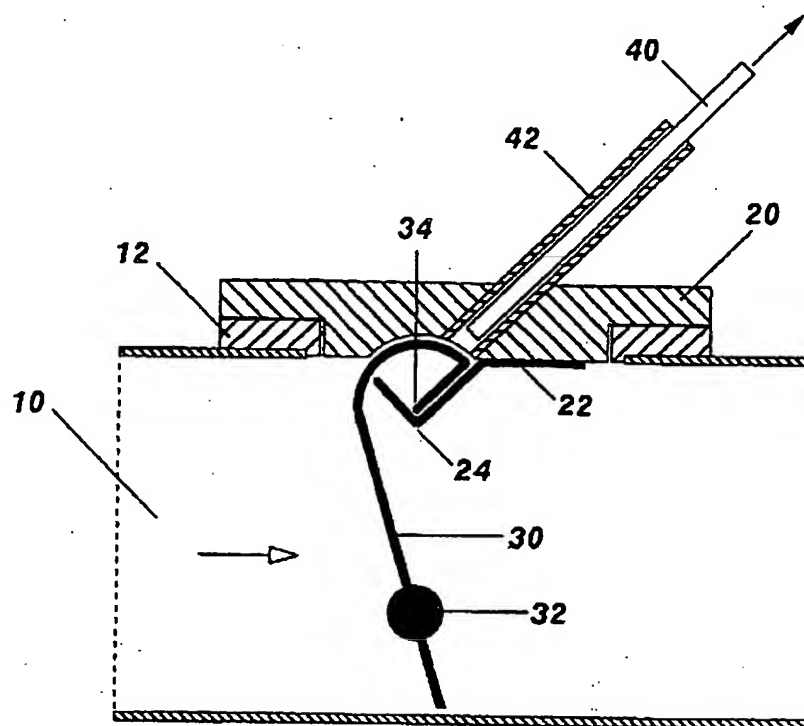


Fig. 1

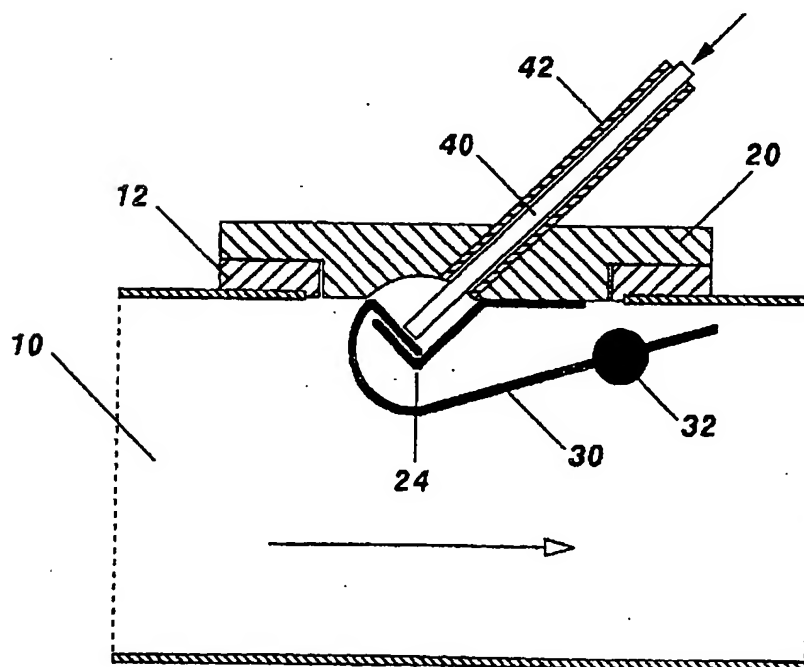
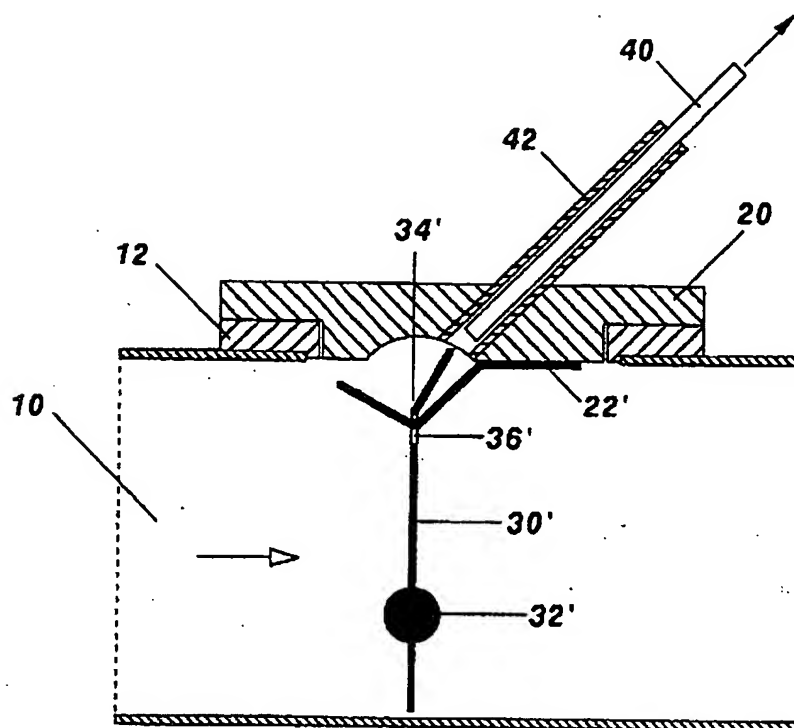


Fig. 2

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**Fig.3**

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**EXHAUST PRESSURE REGULATING VALVE**Field of the invention

5       The present invention relates to an exhaust pressure  
regulating valve for an internal combustion engine,  
comprising an exhaust duct defining a through passage for  
the exhaust gases and a pivoted closure flap for obstructing  
the through passage so as to create a regulated exhaust back  
10   pressure.

Background of the invention

15       An exhaust gas pressure regulator that relies on the  
use of a pivoted closure flap obstructing the gas flow along  
an exhaust gas passage is already known. The pivot of the  
closure flap in the known constructions is a spindle that  
passes through the wall of the duct defining the through  
passage. A control mechanism located outside the exhaust  
20   duct is provided to set the position of the closure flap.  
The control mechanism can be used either to regulate the  
back pressure by feedback closed loop control or to force  
the flap into a wide open position so that there should be  
no unnecessary exhaust back pressure when the engine is  
25   operating under full load.

      The disadvantages of such a system are primarily high  
cost and poor reliability, these two being themselves  
related. Because of the hostile environment, even if  
30   expensive material are used to function over a wide  
temperature range and to withstand the effect of the  
chemically corrosive gases, it is still difficult to achieve  
a gas tight seal that permits free movement of the closure  
flap under all conditions over the entire lifetime of the  
35   exhaust system.

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Object of the invention

The invention seeks to provide a low cost exhaust pressure regulating valve that is capable of reliable  
5 operation in the hostile environment of hot and corrosive exhaust gases.

Summary of the invention

10 According to the present invention, there is provided an exhaust pressure regulating valve for an internal combustion engine, comprising an exhaust duct defining a through passage for the exhaust gases and a closure flap for obstructing the through passage, the closure flap being  
15 freely suspended to pivot under its own weight from a fulcrum lying above its centre of gravity and being deflected by the mass flow of exhaust gases along the through passage thereby creating a regulated exhaust back pressure, the closure flap and its pivot being entirely  
20 contained within the exhaust duct.

In the invention, the closure flap does not have a spindle passing through the wall of the duct and is instead contained entirely within the duct. This circumvents all the  
25 problems of maintaining a seal around the spindle while assuring free movement of the closure flap. This allows the regulating valve to be manufactured from inexpensive materials that need not be machined to a high tolerance and to remain reliable for the entire lifetime of the exhaust  
30 system.

The closure flap does not have an external control mechanism for setting its angular position when it is desired to regulate the exhaust back pressure. The weight of  
35 the closure flap sets the back pressure and free movement is assured by the use of a point or line fulcrum rather than a journal bearing.

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There are times when the position of the closure flap needs to be set externally. For example, the closure flap may need to be forced into a minimum back pressure position for smooth idling and during high load operation.

5

To this end, it is preferred to provide a locking member passing through a wall of the duct for forcing the closure flap into an open position when desired, the locking member being movable between a first position in which it  
10 does not interfere with the free pivoting movement of the closure flap as it swings in response to the exhaust gas flow along the through passage and a second position in which it acts on the closure flap to urge the closure flap into an open position in which minimum obstruction is  
15 presented to the gas flow along the through passage.

In the latter embodiment of the invention, the locking member plays no part in the normal operation of the pressure regulating valve and merely pushes or pulls the closure flap  
20 into an inoperative position when its pressure regulating function is to be overridden. Such a locking member can be mounted at a distance from the closure flap in a cooler and less hostile environment to allow lower cost materials to be used in its construction. The locking member may for  
25 example be a cable or a long rod that is retractable to make no contact with the closure flap and extendible to make contact with the closure flap and pivot it about its fulcrum into its open position.

30 When used in combination with a variable valve timing system in which the intake valve of the engine is advanced to open early while the engine is still in its exhaust stroke, a large quantity of exhaust gases may be forced into the intake manifold of the engine when desired to increase  
35 the residual gases in the engine cylinder. This reduces NOx emissions in the subsequent combustion cycle when these

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exhaust gases are drawn back with fresh charge into the engine.

In a similar manner, when used in combination with a  
5 variable valve timing system in which the exhaust valve of  
the engine is retarded to close late into the intake stroke  
of the cylinder, a larger quantity of exhaust gases can be  
drawn in by the engine to increase the residual gases in the  
engine cylinder, i.e. internal EGR, and thereby reduce NOx  
10 emissions.

The effect of increasing the exhaust gas back pressure  
by the use of a regulating valve in the exhaust system is to  
increase the proportion of hot residual gases in the  
15 combustible charge and if this proportion is increased  
sufficiently then it is possible to achieve controlled auto-  
ignition in the combustible charge, which reduces NOx  
emissions still further. As the weight of the closure flap  
determines the variation of the exhaust back pressure as a  
20 function of the exhaust mass flow, it is possible by  
suitable selection of the weight, to achieve a desired  
proportion of residual gases in the combustible charge under  
certain engine operating conditions. In some cases, it may  
be possible to achieve sufficient levels of internal EGR to  
25 be able to dispense completely with an external EGR system.

It is advantageous to locate the back pressure  
regulating valve in the exhaust system downstream of a  
catalytic converter or an absorption or filter trap.

30

It is known that increasing the exhaust back pressure  
will increase the loading on the engine and in order to  
maintain a predetermined power output, the engine must be  
operated at a higher load setting with the result that the  
35 exhaust gas temperature will increase. By closing the  
regulating valve, it is therefore possible to raise the  
exhaust temperature to improve catalyst light off during

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cold start and to regenerate a trap by raising its temperature under normal driving conditions.

The regulating valve will also act to increase the efficiency of operation of the converter or trap for several reasons. In particular, the regulating valve will increase the gas temperature and molecular density of the exhaust gases surrounding the matrix as well as increasing the residence time of the exhaust gases in the vicinity of the matrix by reducing the space velocity of the exhaust gases through the matrix.

The back pressure regulating valve used as a flow diversion valve in an exhaust system with two alternative flow paths, more of the exhaust gases being forced to flow along one path when the other path is obstructed. For example the two flow paths may have different cooling lengths and the flow diversion valve may be used to regulate the average exhaust gas temperature as it flows through the two flow paths of the exhaust system. In this case the weight of the closure flap can be selected to achieve a desired average temperature in the two paths of the exhaust system under certain engine operating conditions.

#### 25 Brief description of the drawings

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:

30 Figure 1 is a schematic section through an exhaust pressure regulating valve of the invention, the closure flap being shown in a position in which its attitude is determined by the mass flow of exhaust gases along the through passage that it obstructs,

35 Figure 2 is a schematic section similar to that of Figure 1 but showing the closure flap locked in a wide open

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position by the use of an elongate rod serving as a locking member, and

Figure 3 is a schematic section similar to that of Figure 1 but showing an alternative embodiment of the invention.

#### Detailed description of the preferred embodiment

In the drawings, an exhaust duct 10 defines a through passage for exhaust gases in the direction indicated by the arrow. The through passage is of rectangular cross-section and is obstructed by a rectangular closure flap 30 that acts as a pendulum having a weight 32. The pendulum swings freely about a fulcrum defined by a knife-edge 34 on the pendulum resting in a V-shaped trough 24 formed by a plate 22 that is secured to a wall of the duct 10.

To enable assembly of the exhaust pressure regulating valve formed by the closure flap 30, an aperture is formed in the upper wall of the duct 10, the rim of which is strengthened by means of a collar 12. A cover 20 is bolted to the collar 12 and carries the plate 22 on its under surface. The top of the closure flap is quadrant shaped and a part-cylindrical cut-out is formed in the under side of the cover 20 to accommodate it, allowing free swinging movement of the closure flap but preventing it from coming out of the V-shape trough. Prior to the fitting of the cover 20 to the collar 12, the closure flap 30 can be slid sideways between the plate 22 and the cover 20 and once it has been lowered into the duct 10 then it remains permanently trapped and capable only of swing movement about its fulcrum.

A locking member is also provided to lock the closure flap 30 into its wide open position shown in Figure 2. The locking member consists of a rod 40 guided within a sheath 42 that is secured to the cover 20. A seal or packing

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between the rod 40 and the sheath 42 is formed at a location sufficiently far removed from the exhaust duct 10 to be naturally cooled. Because the seal is in a cool location its construction may be inexpensive. The seal is furthermore  
5 only required to allow sliding movement of the rod 40 and its proper functioning in no way affects the free swinging movement of the closure flap 30 when the latter is not locked in its wide open position. In this respect, it will be noted that the rod 40 makes no contact with the closure  
10 flap 30 in Figure 1 and its function in Figure 2 is to force the closure flap 30 into its wide open position by physically pushing it about its fulcrum.

Though the locking member has been shown as a rigid rod  
15 it will be appreciated that it is alternatively possible for it to be formed as a bowden cable for ease of installation. Negligible escape of exhaust gases would take place along the sheath of the bowden cable and it may not be necessary to provide any special means of sealing between the cable  
20 and the sheath.

The operation of the locking member, be it a cable or a rod, can be effected by an actuator located at a distance from the exhaust duct 10 and requiring no special attention  
25 to be paid to its construction on account of operation in a hostile environment. The actuator would receive a signal from the engine management system whenever it is desired to override the pressure regulating function and it may be operated pneumatically, hydraulically or electrically.  
30

The extent of the exhaust back pressure would be dictated by the weight of the pendulum 30 and this may be selected to achieve the desired effect on the internal exhaust gas recirculation to the engine. The exhaust  
35 pressure regulating valve may also be used in one of two branches of an exhaust system lying parallel to one another and the weight of the pendulum 30 may be selected to

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determine the relative proportions of the gas flow through the two branches.

The embodiment of Figure 3 operates in substantially  
5 the same manner as the embodiment previously described and  
differs from it primarily in the manner in which the closure  
flap 30' is suspended. To avoid unnecessary repetition,  
analogous components have been allocated the same reference  
numerals and a prime has been added to the reference numeral  
10 if the component in question has been modified.

The closure flap 30', 32' in the present embodiment is  
formed with two laterally spaced apertures 36' by means of  
which the closure flap is fitted over two bent prongs that  
15 project from the mounting plate 22'. The assembly and  
operation of the closure flap 30' is in all other respects  
the same as the closure flap 30 of the previously described  
embodiment.

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### CLAIMS

1. An exhaust pressure regulating valve for an internal combustion engine, comprising an exhaust duct  
5 defining a through passage for the exhaust gases and a closure flap for obstructing the through passage, the closure flap being freely suspended to pivot under its own weight from a fulcrum lying above its centre of gravity and being deflected by the mass flow of exhaust gases along the  
10 through passage thereby creating a regulated exhaust back pressure, the closure flap and its pivot being entirely contained within the exhaust duct.
2. An exhaust pressure regulating valve as claimed in  
15 claim 1, wherein the closure flap is formed with a quadrant shaped upper end defining a downwardly facing knife edge that rests in a V-shaped trough secured to the duct.
3. An exhaust pressure regulating valve as claimed in  
20 claim 2, wherein the V-shaped trough is formed by a plate secured to the under surface of a cover fitted to an aperture in the upper surface of the exhaust duct, the quadrant shaped end of the closure flap being trapped  
25 between the plate and the cover.
4. An exhaust pressure regulating valve as claimed in claim 1, wherein the closure flap is formed with two apertures by means of which the flap is suspended by the engagement in the apertures of two bent prongs projecting  
30 from a mounting plate secured to the under surface of a cover fitted to an aperture in the upper surface of the exhaust duct.
5. An exhaust pressure regulating valve as claimed in  
35 any preceding claim, further comprising a locking member passing through a wall of the duct for forcing the closure flap into an open position when desired, the locking member

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being movable between a first position in which it does not interfere with the free pivoting movement of the closure flap as it swings in response to the exhaust gas flow along the through passage and a second position in which it acts  
5 on the closure flap to urge the closure flap into an open position in which minimum obstruction is presented to the gas flow along the through passage.

6. An exhaust pressure regulating valve as claimed in  
10 claim 5, wherein the locking member is formed as a rod in a rigid sheath secured to the cover.

7. An exhaust pressure regulating valve as claimed in  
15 claim 5, wherein the locking member is formed as a bowden cable of which the outer sheath is secured to the cover.

8. An exhaust system having an exhaust pipe containing a catalytic converter, an absorption trap, a filter trap or the like after-treatment device and a  
20 pressure regulating valve as claimed in any preceding claim located downstream of the after-treatment device.

9. In combination, an engine having means for varying the timing of at least one of the intake and exhaust valves  
25 and an exhaust system fitted with a pressure regulating valve as claimed in any one of claims 1 to 7 for varying the proportion of internally recirculated exhaust gases.

10. An exhaust system having parallel flow branches  
30 through which exhaust gases from an engine may flow and a pressure regulating valve as claimed in any one of claims 1 to 7 arranged in only one of the two branches to vary the relative proportions of the gas flow along the two branches.

35 11. An exhaust pressure regulating valve constructed, arranged and adapted to operate substantially as

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hereinbefore described with reference to and as illustrated  
in the accompanying drawings.



The  
Patent  
Office

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Application No: GB 9805837.3  
Claims searched: 1 to 11

Examiner: John Twin  
Date of search: 22 July 1998

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): F1B (BB140, B2Q4); F2V (VG4)

Int Cl (Ed.6): F02D 9/04, 9/08, 9/10; F16K 1/16, 1/18, 1/20, 27/02

Other: Online: WPI

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | Relevant to claims |
|----------|---|--------------------|
| A        | GB 1043865 (May)                          | 1                  |
| X        | GB 309649 (Tuckfield) - see eg figure 3   |                    |
| A        | US 4494564 (Fuller)                       |                    |

X Document indicating lack of novelty or inventive step  
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